THE LAW OFFICES OF
MICHAEL R. GARDNER, P.C.
ATTORNEYS AT LAW
1150 CONNECTICUT AVENUE, N.W.
SUITE 710
WASHINGTON, D.C. 20036
(202) 785-2828
FAX (202) 785-1504

RECEIVED
APR 13 1995
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

April 13, 1995

By Hand

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, DC 20554

DOCKET FILE COPY ORIGINAL

Re: IC Docket 94-31

Dear Mr. Caton:

On behalf of CellularVision, enclosed please find an original and four (4) copies of its Reply Comments in the above-referenced proceeding.

Please direct any questions regarding this matter to the undersigned.

Sincerely,

Michael R. Gardner

Michael R. Gardner
Counsel for CellularVision

Enclosure

cc Attached Service List

No. of Copies rec'd 0+4
List A B C D E

RECEIVED

APR 13 1995

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
Preparation for International Telecommunications Union World Radiocommunication Conferences	)	IC Docket No. 94-31

DOCKET FILE COPY ORIGINAL

REPLY COMMENTS OF CELLULARVISION

CellularVision,[1] by its attorneys, hereby files Reply Comments in response to the Commission's Second Notice of Inquiry in the above-referenced docket seeking comment on the FCC's preliminary proposals for the 1995 World Radiocommunication Conference ("WRC-95") and future World Radiocommunication Conferences ("WRCs"). See Preparation for International Telecommunication Union World Radiocommunication Conferences, FCC 95-36 (released January 31, 1995) ("Second NOI").

[1] For purposes of this document, references to "CellularVision" include the following related companies controlled by common principals, as well as strategic investors such as Bell Atlantic Ventures XXIII, Philips Electronics North America Corporation and J.P. Morgan Investment Management: Suite 12 Group, which pioneered the development of the CellularVision technology for the Local Multipoint Distribution Service in the 27.5-29.5 GHz band and was tentatively awarded a pioneer's preference by the Commission, see Notice of Proposed Rulemaking, Order, Tentative Decision and Order on Reconsideration ("First NPRM"), 8 FCC Rcd 557 (1993), CellularVision Technology and Telecommunications, Inc., which holds the patent for the CellularVision technology, and CellularVision of New York, L.P., which operates a commercial LMDS video service as an alternative to cable television in the New York Primary Statistical Area ("PMSA") in the 27.5-28.5 GHz band pursuant to a commercial license granted by the Commission in 1991. See Hye Crest Management, Inc., ("Hye Crest Order"), 6 FCC Rcd 332 (1991).

I. INTRODUCTION

CellularVision is the inventor and pioneer of a revolutionary wireless broadband, interactive microwave cellular technology, known as the Local Multipoint Distribution Service ("LMDS"), which provides low-cost video, voice and data service. In 1991, the Commission granted Hye Crest Management, Inc., CVNY's managing partner, a five-year commercial license to operate LMDS in the 27.5-28.5 GHz band throughout the New York Primary Metropolitan Statistical Area ("PMSA"). See Hye Crest Management, Inc., 6 FCC Rcd 332 (1991). Accordingly, CVNY currently operates a high-quality 49-channel video programming alternative to cable television in Brighton Beach, New York, and is presently preparing to service subscribers throughout the vast 1,147 square mile New York PMSA, its designated service area. Recognizing that LMDS could offer public interest benefits as a viable alternative to franchised cable operators, the Commission formally proposed to redesignate the 27.5 - 29.5 GHz band from terrestrial point-to-point services to terrestrial point-to-multipoint services, with two 1 GHz licenses per service area.[2]

Fixed Satellite Service ("FSS") and Mobile Satellite Service ("MSS") proponents are also vying for the right to utilize the 28 GHz band for their system feeder links, including Teledesic Corporation ("Teledesic"), Hughes Communications Galaxy, Inc. ("Hughes") and Motorola Satellite Communications, Inc. ("Motorola"). While

[2] See Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.5-29.5 GHz Frequency Band and to Establish Rules and Policies for Local Multipoint Distribution Service, CC Docket No. 92-297, Notice of Proposed Rulemaking, Order, Tentative Decision and Order on Reconsideration, 8 FCC Rcd 557 (1993); Second Notice of Proposed Rulemaking, 9 FCC Rcd 1394 (1994).

CellularVision and Motorola successfully developed a framework for the co-frequency sharing of the 28 GHz band between LMDS and MSS during the Commission's LMDS/FSS 28 GHz Negotiated Rulemaking proceeding ("NRMC"), an agreement that was endorsed by 11 members of the NRMC, FSS proponents Hughes and Teledesic refused to embrace reasoned co-frequency sharing techniques that may yet be adopted by the Commission for co-frequency sharing of the 28 GHz band between LMDS and FSS interests.[3] Importantly, Bellcore Communications Research, Inc. ("Bellcore") submitted into the NRMC record a preliminary study demonstrating that mitigation techniques not considered in the NRMC, such as improved FSS earth station antenna sidelobes, could produce "dramatic improvements in interference" that FSS earth station uplinks would cause to LMDS receivers.[4] CellularVision, Motorola, Bell Atlantic, Texas Instruments and other members of the NRMC commissioned Bellcore to continue

---

[3] Although any conflict between LMDS and paper FSS systems would result from FSS earth station uplink interference into LMDS receivers, the FSS proponents steadfastly refused to consider any changes in their system designs, however minor, that could likely reduce the interference potential.

[4] See Interference from FSS Uplinks into LMDS Receivers: The Impact of Improved Antenna Patterns, prepared by Bellcore, submitted as an Addenda to Report of the LMDS/FSS 28 GHz Negotiated Rulemaking Committee in CC Docket 92-297, dated September 23, 1994 (applicable portions attached hereto as Appendix A). LMDS proponents and other objective observers believe that LMDS/FSS co-frequency sharing of the 28 GHz band is readily feasible even before system design changes to the Hughes and Teledesic systems necessarily occur once these paper proposals are subjected to the rigors of public comment where technical and financial realities will impact these systems; at least one FSS paper proposal has been described by the U.S. Small Business Administration as a "pie-in-the-sky system that may or may not get off the ground." See Comments of the Chief Counsel for Advocacy of the United States Small Business Administration in Support of the Motion to Proceed by CellularVision, Feb. 14, 1995, p. 6 (stating that the complexity and cost of Teledesic's proposal "would rival that of the Strategic Defense Initiative")(attached hereto as Appendix B).

its initial analysis, and in the next few weeks Bellcore will release a study demonstrating that LMDS/FSS co-frequency sharing is possible with 99.9% LMDS availability. Meanwhile, the Commission is continuing to deliberate a resolution of the 28 GHz LMDS Rulemaking.

II. THE UNITED STATES POSITION SHOULD BE TO ENSURE MAXIMUM FLEXIBILITY FOR ALL TECHNOLOGIES IN THE 28 GHz BAND TO FLOURISH

The WRC-95 agenda includes a number of proposals regarding technical, regulatory and spectrum allocation issues concerning MSS. Of particular relevance to CellularVision is the issue of MSS feeder links. While CellularVision and MSS proponent Motorola succeeded in developing LMDS/MSS co-frequency sharing rules for the 28 GHz band, CellularVision is concerned that actions taken at WRC-95 with regard to MSS feeder links in the 28 GHz band could have the intended or unintended consequence of prejudging the outcome of the LMDS Rulemaking, and the success of the CellularVision/Motorola Sharing Rule, by preventing or restricting the ability of LMDS to operate in the 28 GHz band. The United States's effort to establish regulations for MSS worldwide must not come at the expense of promising competitive communications technologies, such as LMDS. Thus, CellularVision urges that the Commission appropriately embrace a position at the WRC-95 Conference, and at future WRCs, that maximizes flexible access to the 28 GHz band by all allocated users of that band — LMDS, MSS and FSS interests alike.

Indeed, the WRC-95 agenda explicitly requires that any MSS feeder link allocation made by the U.S. take into account "existing services to which the frequency spectrum to be considered by the [WRC-95] Conference is also allocated." See Agenda for the 1995 World Radio Communications Conference (1994).[5] CellularVision accordingly advocates that the United States neither propose nor endorse any measures regarding the 28 GHz band that concurrently could exclude or inhibit the ability of LMDS to operate robustly in the 28 GHz band — preventing consumers throughout the domestic and global marketplace from reaping the benefits brought by LMDS and other telecommunications providers and alternative services. Moreover, the United States's delegation must be vigilant in its bi-lateral and multi-lateral efforts both before and during the important WRC-95, and subsequent WRCs, to insure that no other country or coalition of countries advances an anti-competitive proposal for the 28 GHz band which would restrict the current flexible allocation of the 28 GHz spectrum for LMDS, FSS and MSS.

III. SPECIFIC PROPOSALS

Specific proposals made by several commenters warrant a brief response. In order to protect non-GSO MSS systems, non-GSO MSS proponents Motorola and Iridium, Inc. ("Iridium") propose that a power spectral density limit of 24dBW/MHz be imposed for terrestrial fixed stations operating in the 29.0-29.5 GHz band, stating that such limits already exist to protect GSO systems. See Iridium Comments, page 23-24; Motorola Comments, page 12-13. Motorola and Iridium also propose that FSS systems in the 29.0-29.5 GHz band operate on a secondary basis to MSS feeder links in the

[5] The current ITU Table of Allocations lists FIXED, FIXED SATELLITE (Earth-to-space) and MOBILE as co-equal in the 28 GHz band. In ITU terminology, "fixed" includes terrestrial point-to-point and point-to-point multipoint communications, such as LMDS.

same band. See Motorola Comments, page 12-13; Iridium Comments, page 22-23. CellularVision is not neccesarily opposed to both of these proposals, to the extent that they do not adversely impact LMDS. However, CellularVision would be opposed to any proposal that would relegate the fixed allocation in the 28 GHz band to secondary status.

Teledesic, which modified its design and added 100 MHz of MSS spectrum, ostensibly so that it may refer to itself as a non-GSO MSS system in order to qualify for non-GSO MSS feeder link spectrum, urges that the United States propose to eliminate the "archaic" regulatory distinction between non-GSO FSS and non-GSO MSS systems. Teledesic Comments at 10-12. While Teledesic claims that such a policy is necessary to ensure sufficient spectrum for all proposed non-GSO MSS satellite systems, its obvious motive appears to be obtaining a WRC allocation specifically tailored to its peculiar paper proposal — an FSS system using non-GSO satellites. Teledesic's self-serving request that non-GSO FSS and non-GSO MSS systems be treated similarly should be rejected. As TRW points out, ". . . any attempt to recast [Teledesic's] service link proposals as non-GSO MSS feeder links is misleading" and "any Commission . . . concession to Teledesic in the U.S. WRC-95 proposals could easily jeopardize any new allocations for true [non-GSO] MSS feeder link systems." See TRW, Inc. Comments, note 23.

Teledesic also argues for an allocation of a minimum of 1000 MHz in the Ka band on a primary basis for non-GSO feeder link systems. Teledesic's unrealistic assertion that 1000 MHz of spectrum is needed in each direction for non-GSO feeder link systems is not surprising given its stubborn refusal to consider sharing the 28 GHz band with LMDS, and its persistent campaigning to push LMDS out of the 28 GHz band. Teledesic's request for 1000 MHz of spectrum is far too large a request for MSS feeder links, as confirmed by contrasting Teledesic's requests for spectrum to the much more limited and realistic requirements as set forth by Motorola and TRW.

IV. CONCLUSION

Based on the foregoing, CellularVision respectfully requests that LMDS, as well as other technologies competing for the 28 GHz band, be given the opportunity to provide viable, robust and competitive telecommunications services domestically and globally. Therefore, any position embraced by the United States regarding spectrum allocation issues involving the 28 GHz band must ensure maximum flexibility for all technologies in the 28 GHz band to flourish, and must not prejudice the outcome of the Commission's ongoing 28 GHz Rulemaking proceeding against the competitive, spectrum efficient LMDS wireless technology.

Respectfully submitted,

CellularVision

By: Michael R. Gardner

Michael R. Gardner
Charles R. Milkis
Rafael G. Prohias

THE LAW OFFICES OF MICHAEL R. GARDNER, P.C.
1150 Connecticut Ave., NW
Suite 710
Washington, DC 20036
(202) 785-2828

Its Attorneys

April 13, 1995

APPENDIX A

Interference from FSS Uplinks into LMDS Receivers: The Impact of Improved Antenna Patterns

Contact:
Dr. Scott Y. Seidel
Bell Communications Research
331 Newman Springs Road
Red Bank, New Jersey 07701
908-758-2928
fax: 908-758-4371

Abstract

This paper investigates the impact of the FSS earth station uplink antenna pattern on the required separation distance between FSS uplink earth stations and LMDS receivers. It is shown that a decrease in earth station antenna sidelobe levels along the horizon can reduce the required separation distance between the terminals under both clear sky and rain conditions by up to one or two orders of magnitude for the scenarios considered here. In fact, Table 2 shows *typical* separations of 100 feet (0.02 miles) at 45 degree LMDS sidelobes may be possible. A reduction in required separation distance corresponds to a decrease in the size of the LMDS cell area where interference is received from an individual FSS earth station. A list of additional factors that may contribute to actual received interference levels lower than the values in the calculations is presented. An explanation is given of how each factor could reduce the interference. Factors that may limit the amount of interference reduction are also discussed. Future studies on co-frequency sharing are suggested to examine the impact of factors not included in previous calculations.

1.0 Introduction and Summary of Results

Interference calculations performed as part of the 28 GHz Negotiated Rule-Making Committee (NRMC) deliberations on interference from FSS satellite uplinks into LMDS receivers showed significant potential for interference. Improved antenna sidelobe performance was one of the mitigation opportunities identified to reduce the level of this potential interference. In order to be very confident that its interference study results were achievable, the Committee agreed during one of its working group meetings to use information on antennas that had been built and tested rather than those on which only design information was available. Where measured antenna range pattern information was not available, ITU masks were to be used as a default; for FSS satellite uplinks, these patterns were specified as the ITU-699 mask. With these guidelines in place, NRMC calculations were performed using antenna patterns submitted by each of the FSS and LMDS proponents. In addition to the analyses performed by the NRMC using these conservative guidelines, it is important to continue to explore potential mitigation that would be achieved by antenna designs that are thought to be theoretically sound and potentially achievable. Contribution NRMC/104, "Comments Concerning Earth Station to LMDS Interference Predictions," submitted by antenna manufacturer Andrew Corp., indicates that antenna improvements on the order of 20-45 dB for off-axis angles between 30-90 degrees may be possible. Since contribution NRMC/104 was one of the many documents introduced to the Committee near the end of its negotiation period, and it therefore did not have a chance to discuss this contribution, a preliminary study of the impact of improved sidelobe levels on co-frequency sharing was undertaken. Calculations presented here show how improved sidelobe levels on the earth station (ES) uplink antennas can be used to reduce the magnitude of the interference problem. The feasibility of obtaining these reduced sidelobe levels is not addressed; a determination of the technical and economic feasibility should be addressed by the antenna manufacturing community and potential users of these antennas.

Results of the analysis presented here indicate that, for the situations studied, application of improved earth station sidelobes as a mitigation technique could typically reduce the previously calculated separation distances by one or two orders of magnitude, depending on the extent of the sidelobe performance that could be achieved. Boresight separation, for example, could potentially be decreased from 28.18 miles to 1.80 or 0.32 miles for the two antenna sidelobe performance improvement scenarios studied. The area of an LMDS cell where an FSS uplink would cause interference would be reduced by improvement in FSS earth station antenna sidelobe discrimination.

2.0 Description of Calculations

2.1 Background

The spreadsheet used to calculate the interference from MSS feeder links into LMDS receivers for the Working Group 2 section of the NRMC final report was modified to allow calculation of interference from FSS uplinks into LMDS receivers. The LMDS system parameters in the appendix to the Working Group 1 Report are used in the calculations. The Teledesic system parameters are derived from Figures 6.2-1 and 6.2-2 in the Working Group 1 Report. Calculations are made for a T1 Teledesic Standard Terminal (TST) interfering into LMDS hub and subscriber receivers for representative system parameters provided by the system proponents. These representative cases were chosen to investigate the magnitude of interference reduction when improved earth station antennas are used. Significant reductions in interference levels should also be expected when improved antenna patterns are implemented on earth station antennas of other FSS systems such as SPACEWAY.

2.2 Propagation Paths and Rain Conditions

Three different radio paths are considered to include the implications of rain fading in this interference analysis. Both the LMDS and FSS uplink systems have a desired transmission path. In addition, there is an interference path between the FSS transmitter and an LMDS receiver. With rain/no rain conditions on each path, there are a maximum of eight possible rain conditions that could occur. A detailed study of the correlation of rain rates on the given paths to determine the probability of occurrence of each rain condition is not available. The maximum number of conditions has been reduced to the following four cases in order to show representative cases including the most probable and worst case interference situations:

1. LMDS desired signal in clear sky
   FSS desired signal in clear sky
   Interference path between systems in clear sky
   This case is the most probable propagation condition.
2. LMDS desired signal in clear sky
   FSS desired signal in clear sky
   Interference path between systems in 21 mm/hr rain condition (up to 4 km maximum rain cell size)
   This case illustrates how rain attenuation on the interference path affects the required separation distance.
3. LMDS desired signal in rain (amount of attenuation as specified by system proponent)
   FSS desired signal in 17.1 dB rain attenuation
   Interference path between systems in clear sky
   This case is believed to be the worst case interference scenario since many FSS systems employ power control to increase transmitter power under rain faded conditions, and LMDS systems may or may not employ power control during rain-faded conditions. In the absence of rain on the interference path, the required separation distances are largest.
4. LMDS desired signal in rain (amount of attenuation as specified by system proponent)
   FSS desired signal in 17.1 dB rain attenuation
   Interference path between systems in 21 mm/hr rain condition (up to 4 km maximum rain cell size)
   This case represents a more likely rain condition than condition 3 mentioned above.

2.3 Antenna Angles

Calculations are performed for an FSS earth station with a boresight elevation angle of 40 degrees and the azimuth pointing in the direction of the LMDS receiver. The earth station antenna is pointing directly "over the head" of the LMDS antenna. This is the worst case geometry for received interference. Three different earth station antenna masks are used in combination with the antenna mask proposed by the LMDS system proponent for four LMDS antenna azimuth angles relative to the boresight pointing directly at the earth station. Angles of 0 (boresight), 5 (just off boresight), 45 (far off sidelobe), and 180 (backlobe) degrees were used. The non-boresight angles are calculated in order to examine the impact of LMDS receiver antenna pointing on the required separation distance/margin to avoid interference.

2.4 Presentation of Results

For each combination of ES antenna discrimination at 40 degrees elevation, LMDS receiver antenna azimuth angle, and rain on the FSS and LMDS desired signal links, the results are presented in several different ways. First, the margin in decibels is calculated under clear sky interference conditions for a 1 km separation between the interference source and LMDS receiver. The required separation under clear sky is calculated based on free space path loss vs. distance plus a 0.02 dB/km atmosphere induced attenuation for climatic zones 3-5. This is the smallest rate of atmospheric attenuation, and was selected in order to provide a conservative estimate of required separation distance. The atmospheric attenuation can be as high as 0.1 dB/km in climatic zone 1. No atmospheric attenuation was considered in the NRMC Working Group 1 calculations, but is included here as a refinement. Next, the margin in decibels is calculated under a 21 mm/hr rain rate along a 1 km interference path. The rain attenuation along the interference path is calculated using the Lin model for terrestrial rain attenuation. The required separation is then calculated based on free space path loss vs. distance plus a 0.02 dB/km atmosphere induced attenuation and rain attenuation. The rain attenuation is calculated using the Lin model for a rain rate of 21 mm/hr over a maximum rain cell size of 4 km. For each minimum required separation under rain conditions, the allocation of path loss to free space, atmosphere, and rain attenuation is presented in the spreadsheet. The required separations under clear sky and rain conditions are summarized at the top of the spreadsheet with distances in miles.

3.0 Spreadsheet Organization and Calculation Assumptions

The spreadsheet describing the calculations is arranged by columns to identify the LMDS system being interfered with. For a given set of system parameters, calculations span three columns. The results in each column represent the FSS earth station antenna mask used. The first column is the ITU-699 mask as used in the NRMC calculations. The second column is for an antenna discrimination of 63 dB which is a 25 dB improvement over the ITU mask. This is labeled as the conservative improvement. A more optimistic improvement is presented in the third column for an antenna discrimination of 78 dB (40 dB improvement). The terms "conservative" and "optimistic" are used to distinguish between the relative improvements in sidelobe levels investigated, and are not intended to reflect the feasibility of implementation. Rows 1-182 are used to step through the interference calculations. Each of seven sets of calculations spans four pages.

3.1 LMDS and FSS Earth Station System Parameters

Lines 1 through 13 are used as column headings for each of the four pages for a set of calculations. These lines list the LMDS and FSS system designs considered in the interference analysis for each set of three columns. LMDS system parameters such as system proponent, link (hub-to-sub or sub-to-hub), modulation, digital data rate, channel bandwidth, antenna pattern used, and date/revision of system parameters are listed in this section on lines 4-10. Line 12 indicates the FSS system under consideration. All calculations are performed for a Teledesic Standard Terminal (TST) operating at a T1 rate.

3.2 Required Separation

Lines 14-20 summarize the clear sky separations required to reduce interference to acceptable levels for the different combinations of ES discrimination at 40 degrees and LMDS receiver antenna azimuth angle. Lines 21-27 summarize operation under rain conditions when the TST is at full power and the interference path undergoes 21 mm/hr rain along a path up to 4 km long. All separation distances are reduced to a maximum of 100 km to incorporate a conservative estimate of the radio horizon distance. Beyond the radio horizon, it is assumed that interference is reduced to acceptable levels. The calculations are based on a flat earth propagation model where the terminals are located at the same elevation above ground level. No blockage is assumed.

3.3 LMDS Signal Link Carrier Level at Cell Edge

Lines 31-40 describe the characteristics of the LMDS signal link for a subscriber located at a distance equal to the cell edge. When LMDS systems employ power control to overcome rain fades, the amount of power control used in the calculations is the minimum necessary to compensate for the rain fade. For lines 31-40, the first column in the set of three columns for a given system denotes the clear sky link budget, and the third column denotes the link budget under rain conditions.

3.4 Interference Density into LMDS

Lines 47-57 are used to calculate the interference density that can be tolerated by the LMDS system receiver. The calculation starts by computing the noise floor of the LMDS receiver. Based on the minimum required C/(N+I) and the carrier level at the cell edge (C), the maximum acceptable interference in a single channel is calculated on line 56. This value is converted to an allowable interference level based on the bandwidth correction as outlined in section 4.2 in the Working Group 1 report.

3.5 Interference Density Generated

Lines 64-78 describe the FSS uplink from the ES to the satellite as a function of antenna mask. The three columns under the calculations for each LMDS system describe how the parameters vary as a function of earth station antenna discrimination as described on line 64. The interference subtotal for clear sky conditions is given on line 72. Lines 73-77 are used to describe the link conditions under rain. Lines 73-76 are not used, and should be ignored. Line 77 indicates that the feeder link system undergoes a 17.1 dB rain fade. The power control required to overcome the rain fade is also 17.1 dB as described in line 77. The interference level subtotals on lines 72 and 78 are the transmitted interference subtotals before any propagation path loss is included.

3.6 LMDS Receiver Antenna Gain

Lines 87-91 represent the antenna gain of the victim LMDS receiver as supplied by the system proponent for antenna azimuth angles of 0, 5, 45, and 180 degrees off boresight.

3.7 Results of Calculations

The results of the calculations are provided on lines 97-182. The case of clear sky conditions on both signal paths are detailed on lines 97-138. Calculations for LMDS boresight are given on lines 99-108. These calculations are repeated for the other LMDS antenna azimuth angles on lines 109-138, and the components of the calculations are identical to the boresight antenna calculations described below.

Line 100 is the path loss required to reduce the interference to an acceptable level. Line 101 presents the margin between the actual interference and the maximum acceptable interference at the LMDS receiver for an interference source located 1 km from the victim in clear sky conditions. Line 101 shows the required separation between the terminals for clear sky conditions (free space path loss, atmospheric attenuation) for the required path loss given on line 100. No radio horizon limitations are imposed. Under 21 mm/hr rain conditions, the margin at 1 km separation is given on line 103. Line 104 shows the required separation between the terminals under 21 mm/hr rain rate conditions. A maximum rain cell size of 4 km is used to limit the amount of rain attenuation observed. Lines 105-108 demonstrate the allocation of the path loss for the required separation on line 104. Line 106 is the free space path loss, line 107 is the atmospheric attenuation, and line 108 is the rain attenuation. All path loss values in the spreadsheet represent positive loss regardless of the sign (+/-) of the number in the spreadsheet cell.

Lines 141-182 summarize the calculations for rain conditions on the FSS and LMDS desired signal paths.

4.0 Results

4.1 Comparison With NRMC Final Report

The first eight spreadsheet pages show the calculations for a T1 TST interfering into a Suite 12/ CellularVision hub-to-subscriber link. The first four spreadsheet pages are used to verify correct operation of the revised spreadsheet. No atmospheric attenuation is used in the calculations, and the LMDS hub transmitter power per channel is -4 dBW. Table 1 below shows a comparison between the required separations under clear sky conditions as calculated here and in the NRMC final report. The values agree to within two tenths of a mile separation. The slight differences can

Table 1: Validation of Revised Spreadsheet

Required Separation (miles) T1 TST -> CellularVision Subscriber Receiver	NRMC Working Group 1 Final Report	Revised Spreadsheet Calculation
Boresight	23.7	23.85
5 degree Sidelobe	N/A	3.00
45 degree Sidelobe	1.50	1.50
180 degree Backlobe	0.0751	0.08

be attributed to numerical round-off or slight differences in exact carrier frequency, and are small enough to provide confidence in the calculations presented here. In addition, calculations are made for a five degree off boresight angle to show how quickly the separation distance decreases for a small angular difference from boresight. This is significant because if affects the amount of cell area where harmful interference is received.

The specific assumptions used under rain-faded conditions were not specified in the Working Group 1 final report. Hence, a direct comparison with the report is not possible. However, it is apparent that the WG 1 calculations assumed the rain cell existed over the entire length of the interference path. This can be seen in the case of interference from a T1 TST into a CellularVision subscriber antenna boresight aligned with the interferer. Under clear sky conditions, the required separation was over 23 miles. When the TST increased its output power by 17.1 dB to compensate for a rain fade, the required separation was decreased to only 8 miles. The calculations presented here under rainy conditions assume a more realistic maximum rain cell size of 4 km, and hence show larger required separations under rainy conditions than those contained in the Working Group 1 report. A contribution submitted to the Committee at the end of its negotiation period entitled, "The Teledesic System Will Interfere With LMDS," provides the CCIR formula for rain attenuation which was likely used for the Working Group 1 report. The calculations in the Working Group 1 report for systems described by Texas Instruments under clear sky conditions do not take into account the recent implementation of power control.

4.2 Impact of Improved Earth Station Antenna Discrimination

Table 2 shows the required separation under clear sky conditions for a T1 TST interfering with a Suite 12/CellularVision hub-to-subscriber link for different levels of earth station antenna discrimination. The calculations for Table 2 can be found on spreadsheet pages 5-8, and include 0.02 dB/km atmospheric attenuation and a transmitted power of -5 dBW per channel as specified by the system proponent.

Table 2: Reduction in Separation Distance Under Clear Sky Conditions

Required Separation (miles) T1 TST -> CellularVision Subscriber Receiver	ITU-699 38 dB	Conservative Improvement 63 dB	Optimistic Improvement 78 dB
Boresight	28.18	1.80	0.32
5 degree Sidelobe	3.88	0.23	0.04
45 degree Sidelobe	1.96	0.11	0.02
180 degree Backlobe	0.10	0.01	0.00

Table 2 shows the significant reduction in required separation distance when increased sidelobe suppression is employed on FSS earth station uplink antennas. Boresight separations are decreased from 23 miles to less than 2 miles under the conservative improvement, and to less than half a mile with an antenna discrimination of 78 dB. While a two mile separation between an interference source and a victim receiver still represents a major interference problem, this interference occurs only over a small area within the LMDS cell. At just five degrees away from boresight, required separations can be reduced to less than a quarter mile, and at LMDS azimuth angles further away from boresight, the interference is reduced to even lower levels. The number of LMDS subscriber receiver antennas that will be pointed at an FSS earth station is quite small. For an FSS earth station randomly located in azimuthal direction from an LMDS subscriber, there is a less than 3% chance that the earth station will be within +/- 5 degrees of the main beam of the LMDS antenna assuming a two-dimensional calculation. In three dimensions, this probability is reduced even further. As a result, the size of the geographic area where interference is caused is greatly reduced by LMDS antenna discrimination in the azimuth plane. Table 3 shows the required separation between a TST and a cell-edge located Suite 12/CellularVision subscriber under rain conditions. Note that the summary separation distances at the top of the spreadsheet are given in miles, and all other distances given throughout the spreadsheet are given in km. Under rain conditions, the reduction in required separation distance is comparable to that achieved under clear sky conditions.

Table 3: Reduction in Separation Distance Under Rain Conditions

Required Separation (miles) T1 TST -> CellularVision Subscriber Receiver	ITU-699 38 dB	Conservative Improvement 63 dB	Optimistic Improvement 78 dB
Boresight	36.72	2.46	1.09
5 degree Sidelobe	5.20	0.89	0.25
45 degree Sidelobe	2.63	0.56	0.13
180 degree Backlobe	0.50	0.04	0.01

5.0 Additional Factors Which Lead to Reduced Interference

There are several additional factors which lead to reduced interference in "real-world" situations that are not reflected in the calculations. A list of these factors is given below.

1. FSS earth station antennas are not always azimuthally pointed toward the LMDS receiver.

   Interference levels are calculated assuming the FSS earth station antenna is pointed "over the head" of the LMDS receiver. This is appropriate as this is the worst case; however, only a small number of LMDS antennas will be in the azimuth direction of the earth station at any given time. In addition, this direction is constantly changing as the satellite flies overhead.

2. FSS earth station antenna elevation angles are often greater than 30-40 degrees.

   Interference levels are calculated assuming the FSS earth station antenna is at the system-dependent minimum elevation angle of 30-40 degrees. As a non-GSO satellite flies overhead, the elevation angle will often be greater than 30-40 degrees for much of the time.

3. FSS earth stations may be located higher than the LMDS antenna, leading to increased angular discrimination.

   Since FSS earth station antennas require clearance to elevation angles of 30-40 degrees, they will often be located on the tops of tall buildings. In many cases, the LMDS receiver will be at elevations lower than the earth station installation causing an increased angular distance from the earth station antenna boresight. In these cases, the interference would be reduced due to increased antenna discrimination at larger angular distances from boresight.

4. FSS earth stations will not often be at maximum output power, and will only do so only under

heavy rain conditions.

Interference levels were calculated with the earth station at full output power. This only occurs under very heavy rain conditions. The FSS uplinks are designed for high reliability, and as such are designed to overcome *rare* rain occurrences at full output power. As the designed system reliability increases, the amount of time that the earth station would be at full power decreases. If an earth station installation does not cause interference under clear sky conditions, but only when increasing output power to overcome rain fades, then the issue becomes one of relative importance of availability between services.

5. FSS earth stations will not always be transmitting.

   Many individual earth stations will not always be transmitting information, but will be idle. In addition, peak busy hours for business users of FSS uplinks and consumer video entertainment via LMDS do not likely coincide.

6. FSS earth station transmissions may be bursty with a low (~10%) duty cycle.

   Interference from low duty cycle transmissions may either be tolerable by analog modulation systems, or may be reduced by time sharing with digital systems if inter-system synchronization can be achieved.

7. FSS earth station transmissions at T1 rates only interfere with a small number of LMDS video channels. Hence, for analog video, perceived interference may be less than actual interference statistics.

   The bandwidth of a single T1 transmission to non-GSO satellites coincide with only a few LMDS video channels. Due to the variable pointing of uplink antennas, interference may only occur over a short period of time. The specific time when interference occurs on a particular channel may not coincide with use of that channel by the subscriber of the victim receiver. Therefore, interference that occurs may not always be noticed. However, if this interference occurs on a subscriber's favorite channel during an important event, the impact could be severe.

8. FSS uplink antennas may employ higher gain antennas.

   The use of higher gain antennas would allow for a reduction of uplink power for the same EIRP. This would reduce the amount of interference power into an LMDS receiver. In addition, improvements in sidelobe discrimination are likely easier to achieve in higher gain antennas.

9. In typical operating environments, there will often be building and foliage blockage between FSS earth stations and LMDS receivers.

   NRMC interference calculations did not include the effects of building and foliage blockage due to the inability to determine suitable models. In typical operating environments, however, these natural mitigating factors will serve to decrease the likelihood of receiving harmful interference.

10. Many LMDS receivers will have received carrier levels greater than the level received at cell edge.

    NRMC interference levels were calculated with the LMDS receiver at the cell edge since this is the location where the receiver is most sensitive to interference. At locations in the cell that are closer to the hub, received carrier levels are often higher, and higher levels of interference can be tolerated.

11. LMDS subscriber receivers may also be able to employ antennas with reduced sidelobe levels.

Improved sidelobe discrimination of LMDS receiver antennas would lead to reduced interference in situations where the interference source is not in the main beam of the LMDS antenna.

6.0 Additional Factors Which May Limit Achievable Reduction in Interference

1. Building reflections may create additional interference paths.

While building reflections may create additional paths for interference to reach a LMDS receiver, the probability that this interference arrives in the main beam of a highly directional receiver antenna is quite small. In order for interference from a reflected path to be received in the main beam, the receiver must be pointed toward the reflecting surface. The desired signal from the hub must also be reflected off that same surface. For this situation to exist, the interference source must either be located at the hub or be reflected by surfaces very close to the hub antenna mount. While building reflections may cause interference to be received from directions where sidelobes are higher than the sidelobes pointed directly at the interference source, it is highly unlikely that interference will be received through the main beam of a highly directional LMDS receiver. Antennas with wider beamwidths are more susceptible to receiving interference from reflected paths. This susceptibility can likely be reduced by requiring a minimum separation distance between FSS earth stations and LMDS hubs which employ broad beamwidth antennas.

2. FSS earth stations may occasionally be located below LMDS receiver antennas leading to reduced angular discrimination (hub or subscriber on top of a building and earth station at ground level).

FSS earth station antennas require clearance down to a 30-40 degree elevation angle, and will likely be located in areas with a clear view to potential satellite locations. This reduces the probability that LMDS antennas will be located at higher elevations than FSS uplink antennas. This also serves to reduce the likelihood of building reflections.

3. Multiple earth stations may be located in an LMDS service area.

While multiple earth stations may be located in an LMDS service area, the satellite footprint is much larger than any single LMDS cell. Some form of multiplexing between any two satellite uplink signals is required in order for the satellite receiver to distinguish between the two transmissions. Possibilities include frequency and time division multiple access. Hence, there is no aggregation of interference sources on the same frequency at the same time. The effect of multiple interferers would be to increase the size of the cell area where uplink transmissions would cause unacceptable interference. For analog video LMDS systems, this interference would be spread over different subscribers and/or different channels.

7.0 Further Study

The calculations presented here provide the minimum separation distances required to avoid interference from FSS earth station uplinks for specific LMDS azimuth angles. Interference calculations presented in the Working Group 1 report show the "exclusion zone" area for all azimuth angles around an LMDS receiver where an FSS uplink cannot be located in order to avoid causing interference. The percentage of cell area excluded from FSS transmissions for multiple LMDS receivers in a coverage area was calculated. The contribution submitted to the Committee at the end of its negotiation period entitled, "The Teledesic System Will Interfere With LMDS," calculates the probability that a given percentage of an LMDS cell is interfered with. Presentation of the results calculated here in either of the above formats was not possible to allow timely submission of this paper. Future calculations could show how improved earth station antenna sidelobe performance can decrease the cell area where FSS uplink transmissions would cause interference. Additional cases of interference from a Teledesic Giga-Link (TGL) terminal or a SPACEWAY terminal can be considered. Monte Carlo simulation of the factors listed in Sections 5 and 6 above can be used to also address the impact of antenna improvements on the importance of these factors in interference calculations. Additional mitigating opportunities such as hub diversity and operational techniques can be studied.

8.0 Conclusions

This paper calculates the interference from a Teledesic Standard Terminal (TST) operating at a T1 rate into LMDS hub and subscriber receivers. The spreadsheet used to calculate interference from MSS feeder links into LMDS receivers for the NRMC Working Group 2 report was modified to calculate the interference received from FSS earth stations. Calculations were compared with the calculations presented in the Working Group 1 report to validate the revised spreadsheet under identical system parameters and model assumptions. One of the mitigation opportunities identified in Chapter 5 of the Working Group 1 report was improved antenna sidelobe discrimination. Document NRMC/104 indicated that antenna sidelobe improvements on the order of 20-45 dB over the ITU-699 antenna mask may be possible. The impact of such large potential improvements was investigated here.

Under clear sky conditions, calculations of required separation distance show a reduction from around 28 miles to just under 2 miles when a TST uplink is in the main beam of a Suite 12/CellularVision subscriber located at the edge of coverage for a 25 dB improvement in TST antenna discrimination. A 40 dB sidelobe improvement leads to required separations on the order of just a third of a mile in the main beam of the LMDS antenna. An interferer occurs in the main beam of the LMDS receiver antenna relatively infrequently (less than 3% of the locations). When the LMDS subscriber is pointed away from the interference source by at least five degrees, required separations are reduced to less than a quarter of a mile and are typically reduced to hundreds of feet (see Table 2). A reduction in required separation distance corresponds to a decrease in the size of the cell area where interference is received from an individual earth station. Similar dramatic improvements in interference levels are achieved for LMDS system descriptions provided by Video/Phone and Texas Instruments. For hub receivers, required separation distances are reduced from four miles to less than a quarter mile. Although not analyzed, interference from other FSS earth station transmitters that utilize antennas that fall under the ITU-699 mask such as SPACEWAY would also be significantly reduced. Under rain conditions, when the TST is at full output power, the required separation is slightly larger, but is still significantly reduced when improved antenna pattern sidelobes are implemented.

These calculations are *still* performed for essentially free space propagation. Additional real-world factors such as building and foliage blockage would likely serve to further reduce interference levels at LMDS receivers. Monte Carlo simulations can be performed to determine the full impact of improved sidelobe levels on the amount of area where FSS uplink transmissions would cause unacceptable interference into LMDS receivers.

When improved sidelobe levels are employed on FSS uplink antennas, interference is reduced to levels that are much closer to being acceptable by LMDS receivers. This is equivalent to reducing the amount of geographic area within an LMDS cell where interference is present. If these antenna patterns are realizable and economically viable, then the magnitude of co-frequency sharing problems is greatly reduced, and the implementation of some additional mitigating factors may reduce interference to tolerable levels. Hence, additional consideration should be given to co-frequency sharing between FSS and LMDS in the 28 GHz frequency band.

APPENDIX B

U.S. SMALL BUSINESS ADMINISTRATION
WASHINGTON, D.C. 20416

OFFICE OF CHIEF COUNSEL FOR ADVOCACY

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Rulemaking to Amend Part 1 and Part 21	)	CC Docket No. 92-297
of the Commission's Rules to Redesignate	)	
the 27.7 -29.5 GHz Band and to	)	
Establish Rules and Policies for Local	)	
Multipoint Distribution Service	)	

Comments of the Chief Counsel for Advocacy of the United States Small Business Administration in Support of the Motion to Proceed by CellularVision

---

Jere W. Glover, Esq.
Chief Counsel
Barry Pineles, Esq.
Assistant Chief Counsel
Office of Advocacy
United States Small Business Administration
409 3rd Street, S.W.
Washington, DC 20416
(202) 205-6532

FEB 14 1995

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Rulemaking to Amend Part 1 and Part 21 of the Commission's Rules to Redesignate the 27.7 -29.5 GHz Band and to Establish Rules and Policies for Local Multipoint Distribution Service	)	CC Docket No. 92-297

Comments of the Chief Counsel for Advocacy of the United States Small Business Administration in Support of the Motion to Proceed by CellularVision

---

I. *Introduction*

Since 1983, the Federal Communications Commission (FCC or Commission) has undertaken a number of steps to increase the availability of wireless multichannel video program providers. The first major step in that regard was the reallocation of eight channels to multipoint distribution systems.[1] Then, in 1986, the Commission issued experimental licenses for local multipoint distribution systems (LMDS) to be tested in the 28 GHz band.[2] The FCC then granted a license to operate a LMDS system in Brooklyn, New York to CellularVision. Finally, the Commission,

---

[1] Multipoint distribution systems operate like the typical cable television system but utilize high frequencies (generally microwaves) for transmission to subscribers receptor antennae.

[2] LMDS is a form of MDS that utilizes cellular-type technology for transmission.

issued a notice of proposed rulemaking to redesignate the 28 GHz band for use by LMDS providers.[3]

At that point, progress ceased due to potential competing interests. The 28 GHz band is currently assigned to use for fixed satellite services (FSS). Three major satellite system purveyors and the National Aeronautics and Space Administration (NASA) objected to LMDS because terrestrial use of the 28 GHz band might result in interference with transmission or reception of satellite signals in that band.

In an attempt to resolve this dispute, the FCC commenced a negotiated rulemaking in which all interested participants were invited. The scope of the negotiated rulemaking was limited to determining whether LMDS could share or otherwise coexist with FSS in the 28 GHz band. While one entity, Motorola, agreed to share spectrum, the other major proponents of FSS could not agree to a resolution concerning the shared use of the spectrum.[4]

---

[3] 8 FCC Rcd 557 (1993).

[4] The Office of Advocacy supported the institution of negotiated rulemaking but took no position on whether the 28 GHz band could be shared by terrestrial and satellite uses. However, given Motorola's investment in its Iridium system and its apparent satisfaction that some type of spectrum-sharing was possible, the Office of Advocacy presumes that the technical problems cited by other FSS proponents could have been overcome.